

Table 1. Summary Evaluation of BDCP Conservation Element Bundles by Covered Fish Species

Effects Categories

B-L ● = low beneficial effects at population level

B-M ●● = moderate beneficial effects at population level

B-H ●●● = high beneficial effects at population level

NE = negligible or no effect

A-L ○ = low adverse effect at population level

A-M ○○ = moderate adverse effects at population level

A-H ○○ = high adverse effects at population level

U = unknown

Certainty Categories

☐ **C-L** = low level of certainty regarding assessment of bundle outcomes

☐☐ **C-M** = moderate level of certainty regarding assessment of bundle outcomes

☐☐☐ **C-H** = high level of certainty regarding assessment of bundle outcomes

Conservation Element Bundles	COVERED FISH SPECIES							
	Smelt		Sturgeon		Salmonids		Sacramento Splittail	
	Effect	Certainty	Effect	Certainty	Effect	Certainty	Effect	Certainty
Water Operations and Conveyance Bundles								
1. Real-time operation of CVP/SWP	B-L ● • Low benefit associated with reduction in entrainment loss	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H	NE • Negligible benefit associated with reduction in entrainment loss, but because relatively few sturgeon are entrained, the level of population benefit would be minimal	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H	B-L ● • Low benefit to more common salmonids; moderate benefit to less common salmonids associated with reduction in entrainment loss; • Benefits depend in part on frequency, magnitude, and duration of export reductions	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H	B-L ● • Low benefit associated with reduction in entrainment loss in most years	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H
2. Reduced demand/Delta diversions	B-M ●● • Potential beneficial effects associated with reduced mortality from entrainment, improvements to water quality and flow conditions, increased food availability and quality, and improved ecosystem processes • Benefits are dependent on the amount of reduction	<input type="checkbox"/> <input type="checkbox"/> C-M	NE • Largely unknown, but probably minimally positive	<input type="checkbox"/> C-L	B-M ●● • Low benefits from improved water quality and flow conditions • Moderate benefit to less common salmonids associated with reduction in entrainment loss; low benefit to more common salmonids • Benefits are dependent on magnitude and seasonal timing of reduction	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H	B-M ●● • Benefits through increased water quantity and quality, but minimized by high tolerance to environmental conditions	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H

Conservation Element Bundles	COVERED FISH SPECIES							
	Smelt		Sturgeon		Salmonids		Sacramento Splittail	
	Effect	Certainty	Effect	Certainty	Effect	Certainty	Effect	Certainty
3. Opportunistic exports	B-L ● <ul style="list-style-type: none">Low benefit associated with reduction in entrainment loss, hydrologic conditions, habitat quality and availability, food availability, and ecosystem processesLow adverse effect associated with reducing mortality of non-native competitors and predatorsBenefits are dependent on the hydrologic conditions, time of year, magnitude, and duration	<input type="checkbox"/> <input type="checkbox"/> C-M	B-M ●● <ul style="list-style-type: none">Low benefit associated with reduction in entrainment loss and reduction in non-native predatorsLow to moderate benefit associated with altering flows to mimic historic hydrologic conditions, and improved spawning habitat quantity and quality	<input type="checkbox"/> <input type="checkbox"/> C-M	B-M ●● <ul style="list-style-type: none">Moderate benefit to less common salmonids associated with reduction in entrainment loss; low benefit to more common salmonidsModerate benefits associated with improved habitat quantityPotentially high benefit associated with upstream flow modifications causing improved water quality, flow conditions, and ecosystem processes, and increased food supply, but depends on time of year exporting occursRelative benefits should be greater for fall-run than spring- and winter-run due to interactions effects between seasonal flows and requirements for cold-water spawning	<input type="checkbox"/> <input type="checkbox"/> C-M	B-M ●● <ul style="list-style-type: none">Low benefit from reduction in entrainment mortality and improved water quality, and reduced non-native competitors and predatorsModerate benefit associated with increased spawning and juvenile rearing habitat quality and quantity, increase food availability, and ecosystem processes	<input type="checkbox"/> <input type="checkbox"/> C-M
4. SDA facility	B-M ●● <ul style="list-style-type: none">Low to moderate benefit associated with reduced entrainment loss, quality and availability of habitat and food, reduction in non-native competitors and predators, and improved ecosystem processesModerate benefit associated with improved hydrodynamicsLong period required to implement relative to species needsBenefits are dependent on the hydrologic conditions, hydraulic residence time, channel velocities, time of year, location, magnitude, and duration	<input type="checkbox"/> <input type="checkbox"/> C-M	A-L ○ <ul style="list-style-type: none">Low positive effect associated with improved flow conditions, accessibility to spawning and juvenile rearing habitat, and reduction in non-native predatorsPotentially low to moderate adverse effect associated with false attraction flows	<input type="checkbox"/> C-L	B-M ●● <ul style="list-style-type: none">Potential adverse effect associated with increased entrainment from two intakes (performance of a new fish screen is unknown), but low effect on overall populationModerate benefit associated with reduced non-native competitors/predators and increased food quality, quantity, and availabilityHigh benefit associated with upstream flow modifications and more natural flows causing improved water quality, rearing habitat, and ecosystem processesPotentially high adverse effect associated with false attraction flows	<input type="checkbox"/> <input type="checkbox"/> C-H	B-M ●● <ul style="list-style-type: none">Adverse effect from increased entrainment associated with two intakes, but low effect on overall populationModerate to high benefit associated with improved water quality and flow conditions, increase in habitat, increased food availability, reduction in non-native competitors and predators, and ecosystem processesImproved conditions not expected in south Delta because low salinity must be maintained	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H

Conservation Element Bundles	COVERED FISH SPECIES							
	Smelt		Sturgeon		Salmonids		Sacramento Splittail	
	Effect	Certainty	Effect	Certainty	Effect	Certainty	Effect	Certainty
5. Isolated facility	B-H ●●● <input type="checkbox"/> C-L	<ul style="list-style-type: none">Low benefits associated with improved habitat diversity, quality, and availabilityHigh benefit associated with virtual elimination of entrainment losses, improvements to hydrodynamic conditions, increased food availability, and increased ecosystem processesLong period required to implement relative to species needs	B-M ●● <input type="checkbox"/> C-L	<ul style="list-style-type: none">Low benefit associated with entrainment loss and reduction in non-native predatorsModerate benefits associated with increased quality and access to spawning and juvenile rearing habitat, food quantity and quality	B-H ●●● <input type="checkbox"/> C-M	<ul style="list-style-type: none">Low benefit associated with reduced entrainment mortalityHigh benefit associated with improved water quality, flow conditions, increased quality and quantity of habitat and migration corridors, increased quantity, quality, and availability of food, and ecosystem processes	B-H ●●● <input type="checkbox"/> C-H	<ul style="list-style-type: none">Low benefit associated with reduced entrainment mortalityModerate benefit associated with reduced non-native competitors and predatorsHigh benefit associated with improved water quality and flow conditions, increased habitat and food quality, quantity, and accessibility, and improved ecosystem processes
6. Bifurcated SDA facility	B-M ●● <input type="checkbox"/> C-L	<ul style="list-style-type: none">Low benefits associated with improved hydrologic conditions, increased habitat diversity, complexity, quality, and availabilityHigh benefits associated with increased food availability and improved ecosystem processesLong period required to implement relative to species needs	B-L ● <input type="checkbox"/> C-L	<ul style="list-style-type: none">Low to moderate beneficial effects associated with reduced mortality, improved flow conditions to improve access to spawning and juvenile rearing habitat, and reduction in non-native predatorsPotentially low adverse effect associated with false attraction flows	B-M ●● <input type="checkbox"/> C-M	<ul style="list-style-type: none">Low benefit associated with reduced entrainment mortalityModerate benefits associated with reductions of non-native competitors/predatorsHigh benefits associated with improved water quality and flow conditions, higher quality and quantity of juvenile rearing habitat and migration corridors, increased food quality, quantity, and availability, and improved ecosystem processesPotentially high adverse effect associated with false attraction flows	B-M ●● <input type="checkbox"/> C-H	<ul style="list-style-type: none">Low adverse effect associated with increased entrainment from two intakesLow benefit associated with reduction in non-native competitors and predatorsModerate beneficial impact associated with improved water qualityHigh beneficial effects associated with increased habitat and food quality, quantity, and availability, and ecosystem processes
7. Dual conveyance facility	B-M ●● <input type="checkbox"/> C-M	<ul style="list-style-type: none">Low benefit associated with improved water quality and flow conditions, increased habitat quality and availability,Moderate improvements to food availability and ecosystem processesPotentially high adverse effect from not being implemented within a time frame needed for the species	A-L ○ <input type="checkbox"/> C-L	<ul style="list-style-type: none">Low benefit associated with reduced entrainment mortality, based on relative use of IF vs. South Delta facilities, and reduction in non-native predatorsLow to moderate benefit effect associated with fluctuating hydrologic conditions, improved access to spawning and juvenile rearing habitat, reduced water quality and food supplyDredging would cause adverse effects on water quality	B-M ●● <input type="checkbox"/> C-M	<ul style="list-style-type: none">Low benefit associated with reduced entrainment mortalityModerate benefits associated with increased food quality, quantity, and availability, reductions in non-native competitors and predators (but less than #5)High benefits associated with improved water quality and flow conditions, increased quality and quantity of rearing habitat and migration corridors (though lower than #5 due to dredging and levee reinforcement)	B-L ● <input type="checkbox"/> C-H	<ul style="list-style-type: none">Low benefit associated with reduced mortality from entrainment and non-native mortality, increased water qualityLow adverse effect associated with reduced flow conditions and water residence time leading to reduced food quantityModerate benefit associated with increased habitat quantity, quality and accessibility

Conservation Element Bundles	COVERED FISH SPECIES							
	Smelt		Sturgeon		Salmonids		Sacramento Splittail	
	Effect	Certainty	Effect	Certainty	Effect	Certainty	Effect	Certainty
8. SJR corridor isolated	A-L ○ □□ C-M <ul style="list-style-type: none">• Low adverse effect associated with increased entrainment, reduced hydrologic residence times, and reduced ecosystem processes• Low benefit associated with food availability• Potentially high adverse effect from not being implemented within a time frame needed for the species		U □ C-L <ul style="list-style-type: none">• Not enough known about sturgeon to evaluate effects, but possible increase in entrainment and decrease in habitat quality and food quantity		B-L ● □□□ C-H <ul style="list-style-type: none">• Low benefit associated with increased food quantity and improve conditions for salmonids emigrating from San Joaquin River system		NE □□□ C-H <ul style="list-style-type: none">• Low adverse effects associated with reduced habitat quality and food production from reduced water residence time• Low benefit associated with reduced mortality from entrainment• Moderate benefit associated with increased food supply	
Entrainment and Predation Mortality Reduction Bundles								
9. Minimize SWP/CVP mortality	NE □□ C-M <ul style="list-style-type: none">• Low benefit associated with reduced mortality from entrainment• Low adverse effect associated with reduced mortality of non-natives		U □ C-L <ul style="list-style-type: none">• Not enough known about sturgeon to evaluate effects, but possible decrease in entrainment		NE □□□ C-H <ul style="list-style-type: none">• Low benefit from reduced predation by non-natives in CCF• Low adverse effect associated with reduction in non-native predators		NE □□□ C-H <ul style="list-style-type: none">• Low benefit associated with reduced mortality from entrainment• Low adverse effect of reduced mortality of non-natives	
10. Minimize non-SWP/CVP entrainment	B-L ● □□ C-M <ul style="list-style-type: none">• Low benefit associated with reduced mortality from entrainment, increased food quality and availability, and improved ecosystem processes• Moderate benefit associated with improved hydrodynamic conditions and water quality if diversions are consolidated/ removed• Low adverse effect associated with reduced non-native mortality from entrainment		B-L ● □□ C-M <ul style="list-style-type: none">• Low benefit associated with reduced mortality from entrainment		NE □□□ C-H <ul style="list-style-type: none">• Likely minimal benefit associated with reduced entrainment• Low adverse effect of reduced mortality of non-native predators/competitors		NE □□□ C-H <ul style="list-style-type: none">• Low benefit associated with reduced mortality from entrainment• Low adverse effect of reduced mortality of non-native predators/competitors	
11. Improve habitat to reduce predation	B-L ● □ C-L <ul style="list-style-type: none">• Low benefit associated with reduced mortality from predation by non-natives, water quality and hydrologic conditions		U □ C-L <ul style="list-style-type: none">• Not enough known about sturgeon to evaluate effects, but possible marginal benefit by reducing predator abundance		B-L ● □□ C-M <ul style="list-style-type: none">• Low benefit associated with reduced predation by non-natives, higher habitat quantity and quality, but dependent on amount of improvements		B-M ●● □□□ C-H <ul style="list-style-type: none">• Marginal benefit associated with increased shallow water habitat• Moderate beneficial effect associated with reduced predation	

Conservation Element Bundles	COVERED FISH SPECIES							
	Smelt		Sturgeon		Salmonids		Sacramento Splittail	
	Effect	Certainty	Effect	Certainty	Effect	Certainty	Effect	Certainty
12. Isolate gravel pits	NE <ul style="list-style-type: none">Outside of species habitat	□□□ C-H	NE <ul style="list-style-type: none">Ongoing sampling indicates captured gravel pits are not a stressor on green or white sturgeon	□□□ C-H	B-L ● <ul style="list-style-type: none">Low benefits associated with reduced predation by non-nativesBenefits will be greatest on San Joaquin, where majority of gravel pits are located	□□ C-M	B-L ● <ul style="list-style-type: none">Low benefit associated with reduced predation by non-natives and marginal increase in shallow habitat	□□□ C-H
13. Install screens on upstream diversions	NE <ul style="list-style-type: none">Outside of species habitat	□□□ C-H	NE <ul style="list-style-type: none">Negligible benefit associated with reduced entrainment loss	□□ C-M	NE <ul style="list-style-type: none">Negligible benefit associated with reduced entrainment loss, but expected to be minimal	□□ C-M	NE <ul style="list-style-type: none">Positive effects of reduced entrainment would be cancelled out by adverse effects of reduced entrainment of predators and competitors	□□□ C-H
Flow-Related Habitat Improvement Bundles								
14. Operate DCC to improve passage	NE <ul style="list-style-type: none">Marginal benefit associated with reduced non-native predator habitat, but expected to be negligible	□□ C-M	NE <ul style="list-style-type: none">DCC gates are currently open during juvenile outmigration period, so no additional benefit	□□ C-M	NE <ul style="list-style-type: none">Gates are already operated to minimize outmigrating salmonid mortality; therefore, effects are minimal	□□□ C-H	B-L ● <ul style="list-style-type: none">Low benefit associated with increased water quality and flow conditions from closed gates	□□□ C-H
15. Open DCC & install screens at DCC & Georgiana Slough	NE <ul style="list-style-type: none">Potential marginal benefit associated with reduced non-native predator habitat	□□ C-M	A-L ○ <ul style="list-style-type: none">Low to moderate adverse effects associated with reduced access to food and habitat in the interior Delta	□□ C-M	B-M ●● <ul style="list-style-type: none">Moderate benefit associated with higher survival from reduced passage into interior DeltaLow adverse effects associated with reduced water quality and flow conditions in interior Delta	□□ C-M	A-L ○ <ul style="list-style-type: none">Low adverse effects associated with reduced water quality, flow conditions and increased toxicsNegligible adverse effect associated with reduced access to food in interior Delta	□□□ C-H
16. Re-operate upstream storage facilities	NE <ul style="list-style-type: none">Outside of species habitat	□□ C-M	B-M ●● <ul style="list-style-type: none">Moderate positive effect associated with increased water quality, creation of attraction flows, barrier passage flow, and improved habitat quality and quantity	□□ C-M	B-M ●● <ul style="list-style-type: none">Moderate benefit associated with increased water quality and flow conditions, increased habitat quantity, and ecosystem processesPotentially low to moderate benefit associated with increased food quality and reduced non-native species	□□ C-M	B-H ●●● <ul style="list-style-type: none">Low positive effects associated with increased food quality and quantity and reduction of non-native competitors and predatorsModerate positive effects associated with increase water quality and flow conditionsHigh positive effects associated with increased accessibility to spawning habitat and improved ecosystem processes	□□□ C-H

Conservation Element Bundles	COVERED FISH SPECIES							
	Smelt		Sturgeon		Salmonids		Sacramento Splittail	
	Effect	Certainty	Effect	Certainty	Effect	Certainty	Effect	Certainty
17. Improve and create bypass and floodway habitat	NE • Outside of species habitat	□□ C-M	B-M ●● • Low to moderate benefits associated with reductions in non-natural mortality, improved water quality, improved availability of habitat, and improved food quality and quantity	□□ C-M	B-M ●● • Moderate benefits associated with reduced abundance of non-natives competitors and predators, increased habitat quantity, increased food quality and quantity, and improved ecosystem processes	□□□ C-H	B-H ●●● • High benefits associated with food and habitat quality, quantity, and accessibility, and improved ecosystem processes	□□□ C-H
Physical Habitat Restoration Bundles								
18. Restore habitat in the north, east, and west Delta	B-H ●●● • Low benefit associated with improved water quality and hydrologic conditions • High benefit associated with improved habitat quality, availability, and complexity, and ecosystem processes • Potential high benefit associated with increased food availability, but largely unknown	□□ C-L	B-H ●● • Moderate to high benefits associated with increased quantity, quality, quantity, and availability of habitat and food	□□ C-M	B-L ● • Low benefits from reduced mortality from non-natives, increased food quantity, improved habitat quality and quantity, and improved ecosystem processes	□□ C-M	B-H ●●● • Low benefits associated with reductions of non-natives • Moderate benefits associated with improved water quality • High benefits associated with increased quality, quantity, and accessibility in habitat and food and improved ecosystem processes	□□□ C-H
19. Restore habitat in the central Delta	B-H ●●● • Similar to but lower benefits than #18 and #21 because central Delta has lower value to smelt than north Delta and Suisun Marsh, but greater than #20 because central Delta has higher value to smelt than south Delta	□ C-L	B-M ●● • Moderate to high benefits associated with increased quantity, quality, quantity, and availability of habitat and food	□□ C-M	B-L ● • Benefits similar to #18, but lower because fewer salmonids pass through central Delta	□□ C-M	B-M ●● • Similar to but lower benefits than #18 because smaller area and less desirable habitat for splittail	□□□ C-H
20. Restore habitat in the south Delta	B-M ●● • Similar to but lower benefits than #18, #19, #21 because south Delta has lower value to smelt than north Delta, central Delta, and Suisun Marsh	□ C-L	B-L ● • Similar to but lower benefits than #18 & 19 because sturgeon enter Delta from the north	□ C-L	B-L ● • Benefits similar to #18, but lower because only steelhead and fall-run salmonids are in San Joaquin River	□□ C-M	B-M ●● • Similar to but lower benefits than #18 because smaller area and less desirable habitat for splittail	□□□ C-H

Conservation Element Bundles	COVERED FISH SPECIES							
	Smelt		Sturgeon		Salmonids		Sacramento Splittail	
	Effect	Certainty	Effect	Certainty	Effect	Certainty	Effect	Certainty
21. Restore Suisun Marsh habitat	B-H ●●● • Similar benefits to #18, but greater than #19 & #21 because Suisun Marsh has higher value to smelt than south and central Delta	<input type="checkbox"/> C-L	B-L ● • Low benefits associated with improved water quality, flow conditions and increased habitat availability, increased food availability	<input type="checkbox"/> C-L	B-L ● • Low benefits from reduced mortality from non-natives, increased food quantity, improved habitat quality and quantity, and improved ecosystem processes	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H	B-H ●●● • Low beneficial effects associated with reduced non-native competitors and predators • Moderate benefits associated with reduced mortality, increase water quality and flow conditions • High benefit associated with increased habitat quantity, quality, and availability for juveniles and adults	<input type="checkbox"/> <input type="checkbox"/> C-M
22. Restore habitat upstream of Delta	NE • Outside of species habitat	<input type="checkbox"/> <input type="checkbox"/> C-M	B-M●● • Low to moderate benefits associated with improved water quality, • Moderate benefits associated with improved access to and quantity of spawning habitat, increased food supply	<input type="checkbox"/> <input type="checkbox"/> C-M	B-H ●●● • High benefits associated with reduced mortality from non-native predators, improving hydrologic conditions, increased quantity, quality, and accessibility of habitat, increased food supply, improved ecological processes	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H	B-H ●●● • High benefits specifically from floodplain restoration (similar to #17)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> C-H